Princeton's Nathaniel Fisch

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DOE Pulse

Science and Technology Highlights from the DOE National Laboratories

Number 169 October 18, 2004

Research Highlights . . .

HIV dementia mechanism discovered

A brain-imaging study at DOE's Brookhaven Lab shows that human immunodeficiency virus (HIV) damages dopamine-associated brain cells in patients with HIV dementia—a type of cognitive decline in the later stages of HIV infection. The brain images, obtained with positron emission tomography (PET) at Brookhaven's Center for Translational Neuroimaging, reveal that patients with HIV dementia have fewer dopamine transporters—proteins that help to recycle the neurotransmitter dopamine—than HIV-negative subjects or HIV-positive patients without dementia. These findings may lead to new, more effective therapies. Future studies will also look at whether treatments to suppress HIV lead to recovery of the dopamine system.

[Karen McNulty Walsh, 631/344-8350; kmcnulty@bnl.gov]

New method for medical implants, chemical detection

In research that may lead to revolutions in bio-sensing and biomedical implants, scientists at DOE's Argonne National Laboratory have pioneered a process to affix organic molecules to the surface of a thin layer of diamond. Biomolecules can be harnessed for a broad range of uses from detecting anthrax spores to helping diabetics monitor their blood sugar. Argonne researchers have developed an innovative way to construct hybrid organic-inorganic interfaces based on conducting diamond thin films, allowing biomolecules such as proteins to be anchored to the surface while preserving their functionality. Research funding was provided by DOE's Office of Science.

[Catherine Foster, 630/252-5580; cfoster@anl.gov]

Theory offers new view of the nucleus

Scientists have known for more than 30 years that protons and neutrons are built of quarks and gluons. But they interpret data from experiments on the nucleus with "effective theories" which ignore this internal structure for the sake of simplicity. Now a new study from DOE's Jefferson Lab, together with the CEA in France, proposes a theory that for the first time incorporates the dynamical changes in the quark-gluon structure of protons and neutrons in the nucleus. Published Sept. 23 in *Physical Review Letters*, it is a first step towards a truly fundamental theory of nuclear structure.

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Ames research a boon to bioanalysis

Studies of individual enzyme molecules by Edward S. Yeung, director of the Chemical and Biological Sciences Program at DOE's Ames Laboratory, define the most sensitive level of detection of biomolecules and reveal that the catalytic activity of the same enzymes differs. The work has inspired many single-molecule studies in other research groups and promises to impact molecular modeling, drug design and catalytic studies. Testimony to Yeung's prolific record of scientific accomplishments fundamental to the field of bioanalysis, is his selection as the first recipient of the newly created Ralph N. Adams Award in Bioanalytical Chemistry, which will be presented to him at the 2005 Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy.

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DOE Pulse highlights work being done at the Department of Energy's national laboratories. DOE's laboratories house world-class facilities where more than 30,000 scientists and engineers perform cutting-edge research spanning DOE's science, energy, national security and environmental quality missions. ***DOE Pulse*** (www.ornl.gov/news/pulse/) is distributed every two weeks. For more information, please contact Jeff Sherwood (jeff.sherwood@hq.doe.gov, 202-586-5806).

Fermilab QCD Contributions extend back three decades

The foundation for the 2004 Nobel Prize in Physics that went to David Gross, David Politzer and Frank Wilczek extends back to their own work 1973. But it also extends to many researchers and experiments working to build the field of quantum chromodynamics, including significant contributions from DOE's Fermilab.

Arie Bodek of the University of Rochester won the prestigious 2004 Panofsky Prize in experimental physics "for his broad, sustained, and insightful contributions to elucidating the structure of the nucleon, using a wide variety of probes, tools and methods at many laboratories" including Fermilab.

"QCD and Collider Physics," co-authored by Fermilab's Keith Ellis

Fermilab muon scattering experiment E26, running from 1970 to 1974, was an original observer of the "scaling patterns" predicted by QCD. Fermilab theorist Bill Bardeen was among those who "established the standard framework for describing the data," as cited by colleague Chris Quigg.

Fermilab theorist Keith Ellis co-authored "QCD and Collider Physics" in 1996 with Bryan Webber of Cavendish Laboratory, University of Cambridge, and James Stirling, University of Durham. The book is both a graduate-level textbook and a standard reference across particle physics.

The 2004 Nobel citation is "for the discovery of asymptotic freedom in the theory of the strong interaction." Gross, Polizter and Wilczek reached the counter-intuitive realization that the strong force actually increases with distance, the opposite of other forces. Thus, the harder we try to pull quarks apart, the tighter the strong force binds them. The strong force ebbs only at small distances, such as those within the proton.

One of the papers listed in the Nobel citation was a Fermilab publication submitted with Wilczek in July 1973 while Gross was visiting Fermilab (which at the time was still called the National Accelerator Laboratory). The paper was subsequently published in Physical Review D.

"It is important to note that this work was done 30 years ago, which means we have to make investments now for 30 years hence," said Fermilab's Ellis. "This is the reason that funding for the sciences should be beefed up."

Submitted by DOE's Fermilab

Princeton's Fisch provides needed fusion insight

Nathaniel Fisch

Nathaniel Fisch, a Princeton University professor and theoretical physicist at the U.S. Department of Energy's Princeton Plasma Physics Laboratory (PPPL), has persevered in finding novel ways to use plasma waves to produce electric current. Plasma is a hot, ionized gas that serves as the fuel for nuclear fusion. Fisch's patient efforts led to his discovery of new ways of driving current by injecting radio waves into the plasma. These wave-induced currents can enable fusion reactors, called tokamaks, to operate continuously, which is necessary for an economical and practical fusion reactor.

PPPL Director Rob Goldston said, "Professor Fisch's analyses of techniques to use radio waves to drive electrical currents in plasmas are as elegant and insightful as they are practical. His theoretical work and close collaboration with the experimentalists opened the way for a wide range of experiments and further analyses, and led to a substantial field of research on current-drive in toroidal plasmas. Indeed, sustainment of currents using radio waves may prove to be an essential ingredient in the steady-state operation of fusion power systems."

Fisch specializes in theoretical plasma physics with applications to controlled nuclear fusion, plasma devices, lasers, and astrophysics. In addition to his contributions to the field of plasma physics, he has played an influential role in shaping graduate education in plasma physics. At Princeton University, he is Director of the Program in Plasma Physics, which is widely recognized as one of the world's premier graduate programs in plasma physics. At PPPL, he is Associate Director for Academic Affairs and Head of the Laboratory's Hall Thruster Experiment.

On November 8, Fisch will receive one of seven 2004 E. O. Lawrence Awards for his discovery of ways to use plasma waves to produce electric current.

Submitted by DOE's Princeton Plasma Physics Laboratory